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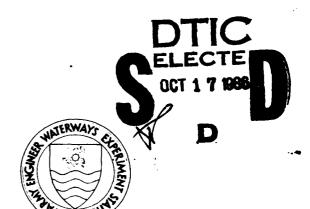# WHITE-TAILED DEER TRACK COUNT CENSUS

Section 6.4.2, US ARMY CORPS OF ENGINEERS
WILDLIFE RESOURCES MANAGEMENT MANUAL

by

Wilma A. Mitchell

Environmental Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi   39180-0631

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July 1986
Final Report

DTIC FILE COPY

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

| REPORT DOCUMENTATION PAGE | | | Form Approved<br>OMB No 0704-0188<br>Exp Date Jun 30, 1986 | | |
|---|---|---|---|---|---|
| 1a. REPORT SECURITY CLASSIFICATION<br>Unclassified | | | 1b RESTRICTIVE MARKINGS AD73207 | | |
| 2a SECURITY CLASSIFICATION AUTHORITY | | | 3. DISTRIBUTION/AVAILABILITY OF REPORT<br><br>Approved for public release;<br>distribution unlimited. | | |
| 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE | | | | | |
| 4. PERFORMING ORGANIZATION REPORT NUMBER(S)<br><br>Technical Report EL-86-52 | | | 5. MONITORING ORGANIZATION REPORT NUMBER(S) | | |
| 6a. NAME OF PERFORMING ORGANIZATION<br>USAEWES<br>Environmental Laboratory | 6b. OFFICE SYMBOL<br>(If applicable) | | 7a. NAME OF MONITORING ORGANIZATION | | |
| 6c. ADDRESS (City, State, and ZIP Code)<br><br>PO Box 631<br>Vicksburg MS 39180-0631 | | | 7b ADDRESS (City, State, and ZIP Code) | | |
| 8a. NAME OF FUNDING/SPONSORING<br>ORGANIZATION<br>US Army Corps of Engineers | 8b OFFICE SYMBOL<br>(If applicable) | | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER | | |
| 8c. ADDRESS (City, State, and ZIP Code)<br><br>Washington, DC 20314-1000 | | | 10. SOURCE OF FUNDING NUMBERS | | |
| | | | PROGRAM<br>ELEMENT NO. | PROJECT<br>NO | TASK<br>NO | WORK UNIT<br>ACCESSION NO<br>EIRP 31631 |

| 11. TITLE (Include Security Classification) |
|---|
| White-Tailed Deer Track Count Census: Section 6.4.2, US Army Corps<br>of Engineers Wildlife Resources Management Manual |

| 12. PERSONAL AUTHOR(S) |
|---|
| Mitchell, Wilma A. |

| 13a TYPE OF REPORT<br>Final report | 13b. TIME COVERED<br>FROM _____ TO _____ | 14 DATE OF REPORT (Year, Month, Day)<br>July 1986 | 15 PAGE COUNT<br>22 |
|---|---|---|---|

| 16. SUPPLEMENTARY NOTATION |
|---|
| Available from National Technical Information Service, 5285 Port Royal Road, Springfield,<br>VA 22161. |

| 17. | COSATI CODES | | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) |
|---|---|---|---|
| FIELD | GROUP | SUB-GROUP | Deer density   Track count census<br>*Odocoileus virginianus* White-tailed deer census |
| | | method | |

| 19 ABSTRACT (Continue on reverse if necessary and identify by block number) |
|---|

A track count census for white-tailed deer (*Odocoileus virginianus*) is provided as
Section 6.4.2 of the US Army Corps of Engineers Wildlife Resources Management Manual.
This technique is one of several methods that the Corps District or project biologist may
employ to estimate white-tailed deer populations on project lands. Aspects of the census
discussed in this report include regional application, timing, sampling design, site
preparation, counting procedure, and data analysis and interpretation.

The track count census has been primarily adapted for use on forested lands with
sandy soils and flat-to-rolling terrain. Although this technique has limited geographical
application, it has been used successfully in areas of Florida, Texas, and the midwestern
states. Regional application and optimum seasonal timing are discussed in this report,
and transect specifications and criteria for site selection are given. The preparation
of transect lines is described, and the counting procedure is outlined in detail. The
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| 20 DISTRIBUTION/AVAILABILITY OF ABSTRACT<br>☑ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS | 21 ABSTRACT SECURITY CLASSIFICATION<br>Unclassified | |
|---|---|---|
| 22a NAME OF RESPONSIBLE INDIVIDUAL | 22b TELEPHONE (Include Area Code) | 22c OFFICE SYMBOL |

**DD FORM 1473**, 84 MAR   83 APR edition may be used until exhausted   SECURITY CLASSIFICATION OF THIS PAGE
           All other editions are obsolete       Unclassified

19. ABSTRACT (Continued).

formulas used for determining population density and appropriate sample size are accompanied by numerical examples that illustrate the calculations and statistics. A reproducible form is also provided for recording track count data.

## PREFACE

This work was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the Environmental Impact Research Program (EIRP), Work Unit 31631, entitled Management of Corps Lands for Wildlife Resource Improvement. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker, OCE, and Mr. David Mathis, Water Resources Support Center.

This report was prepared by Dr. Wilma A. Mitchell, Wetlands and Terrestrial Habitat Group (WTHG), Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES). Mr. Chester O. Martin, Team Leader, Wildlife Resources Team, WTHG, was principal investigator for the work unit. Individuals who contributed information to the report were Mr. Michael Brooks, Florida Game and Fresh Water Fish Commission, Tallahassee; Mr. Carlton Chapell, Florida Game and Fresh Water Commission, Ocala; Dr. Carl L. Bennett, Jr., Michigan Department of Natural Resources, East Lansing; Mr. Richard J. Moran, Michigan Department of Natural Resources, Houghton Lake Heights; Mr. Jack J. Mooty, Minnesota Department of Natural Resources, Grand Rapids; Mr. Gary E. Spencer, Texas Parks and Wildlife Department (TPWD), Jasper; Mr. Horace G. Gore, TPWD, Austin; and Mr. David R. Synatzske, TPWD, Artesia Wells.
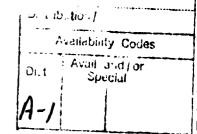
This report was prepared under the general supervision of Dr. Hanley K. Smith, Chief, WTHG, EL; Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL; and Dr. John Harrison, Chief, EL. Dr. Roger T. Saucier, WES, was Program Manager, EIRP. The report was edited by Ms. Jessica S. Ruff of the WES Information Products Division.

COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Dr. Robert W. Whalin is Technical Director.

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NOTE TO READER

This report is designated as Section 6.4.2 in Chapter 6 -- CENSUS AND SAMPLING TECHNIQUES, Part 6.4 -- MAMMAL SURVEY/CENSUS TECHNIQUES, of the US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a separate Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 6.

# WHITE-TAILED DEER TRACK COUNT CENSUS

Section 6.4.2, US ARMY CORPS OF ENGINEERS
WILDLIFE RESOURCES MANAGEMENT MANUAL

The track count census presented here is designed to relate the number of sets of deer tracks crossing transect lines to the total deer population in a given area. This procedure applies specifically to populations of the white-tailed deer (*Odocoileus virginianus*). The census produces an index to the density of a deer population and provides the most useful information when conducted annually to estimate changes in density over time.

The technique is based on research by Tyson (1959) whose studies showed that a 1:1 ratio existed between the number of tracks per linear mile and the number of deer per square mile in pine-oak habitats of Florida. Observations of individual animals indicated that deer moved nightly within an average range of approximately 1 square mile and returned to the same general location to spend the day. Therefore, the average daily range of deer in this area was determined to be 1 mile, and a formula was developed to convert track counts to population density.

The track count census is most suitable for use in heavily wooded areas and in regions of high temperature and humidity. Direct count methods (deer drives, Hahn cruise, spotlight counts, and aerial census) are unreliable in dense forest cover because they require high visibility. The pellet group

survey has been used successfully in arid regions of the United States but is not effective in warm, humid climates because of rapid deterioration of pellets (Downing et al. 1965). Estimates of population density derived from track counts have shown significant correlation with those obtained from deer drives in Florida (Tyson 1959), the Hahn cruise in Texas (Daniel and Frels 1971), and pellet group surveys in Minnesota (J. J. Mooty, Minnesota Department of Natural Resources, pers. commun., 1981) and Michigan (R. J. Moran, Michigan Department of Natural Resources, pers. commun., 1981).

## CAUTIONS AND LIMITATIONS

Major constraints of the track count census are (1) highly specific habitat requirements for transects (as described below under Regional Application) and (2) the unreliability of results for especially high or low population densities. The technique is most reliable for estimating populations of approximately 30 deer/square mile (Daniel and Frels 1971). Populations of more than 50 deer/square mile may be overestimated, whereas those of less than 20 deer/square mile tend to be underestimated (Daniel and Frels 1971, Davis et al. 1978). Harlow and Downing (1967) suggested that the track count census was not feasible in low-density populations of the Southeast because of the large number of samples required to detect change.

Home range information for an area should be obtained from state wildlife sources before a census is initiated. Although Severinghaus and Cheatum (1956) also found the home range of white-tailed deer to approximate 1 mile in the northern United States, studies in other regions have shown wide variations in average home range size (Marchinton 1968, Pledger 1975, Inglis et al. 1979, Ockenfels 1980, Mott 1981, and Tucker 1981). With appropriate local home range data, calculation adjustments can be made for populations whose average daily ranges deviate from 1 mile. If this information is not available, regional data for white-tailed deer populations provided in Chapter 4, Species Accounts, may be used. The manager should be aware, however, that variation may also occur from location to location within any region.

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# REGIONAL APPLICATION

The track count census for white-tailed deer has been adapted primarily for use on forested lands with sandy soils and flat-to-rolling terrain. Track counts have been routinely conducted in the Pineywoods and Post Oak Savannah vegetational areas of Texas and in pine-oak uplands and pine-scrub oak habitats of Florida. The technique is currently under investigation for use in forests of Michigan (Bennett et al. 1980) and Minnesota (Mooty 1980).

Proper moisture and soil texture are essential for accurate counts. Soils that are rocky or too loose cannot maintain track imprints, especially in arid regions such as the Southwest where tracks are subject to wind removal. The technique is difficult to apply on clay soils because of difficulties in preparing the counting surface and obliterating old tracks. Thus, the census has limited application for widespread geographical use.

# TIMING

The optimum time for conducting track counts is during July and August. Adult populations are more stable in summer than during other seasons of the year because concentrations of deer have dispersed and less movement occurs between areas. Tyson (1959) reported that by July individuals appeared to have distinct home ranges. Research in Minnesota (Kohn and Mooty 1971) indicated that deer neither preferred nor avoided roadsides from July 1 through August 15. In many regions of the country the peak of fawning has been completed by July 1; therefore, a large segment of the fawn population will be included in a midsummer census. Track counts are conducted during July and August in Florida and from mid-June through mid-August in Minnesota; they have been run from May through July in Texas. Counts should be initiated as early as possible, so that sufficient replicates can be made to acquire an adequate sample size (refer to explanation under Data Analysis and Interpretation).

# SAMPLING DESIGN

## Site Selection

Transect lines chosen for track count surveys should be well distributed in vegetation types representative of each sample area. Dirt roads are preferable, but fire lanes, logging roads, or pipeline and powerline rights-of-way may be used if not overgrown with vegetation. The soil must be firm

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enough to retain deer tracks, yet loose enough to be smoothed by dragging. Suitable soils are high in sand content and vary from sandy to sandy loam or loamy sand. Location of transects on flat-to-rolling terrain will minimize erosion that could occur with site preparation.

The habitat conditions inherent in making good counts prohibit the completely random selection of routes. Transect lines must be located on roads that are relatively free of fences, vehicular traffic, and livestock disturbance. In some areas of the country, paved rural roads eliminate transect possibilities and may be so prevalent that an area cannot be sampled (Mooty 1980). Bias may occur if the selected routes have physical features that attract deer, such as creeks, springs, or logged areas concentrated along the roads.

## Transect Specifications

Transects vary from 1 to 10 miles in length and are usually divided into 1/2-mile segments for counting. Transects of 1 mile will likely be continuous, but longer lines may be broken at the segment boundaries if vegetation is not uniform or if the habitat contains obstructions such as streams or rocky soil. Transects should be 3 to 6 ft wide and located on one side of the road, thus permitting vehicular traffic.

The number of transects depends upon the size of the area to be censused. In Florida, 1 mile of transect line is established per 10,000 acres on areas greater than 100,000 acres; however, the percentage of lines per 10,000 acres is increased on areas of 70,000 acres or less (Jeter 1965). If an area contains as few as 10,000 acres, 1 mile of transect line per 1000 to 2000 acres will be required.

## SITE PREPARATION

### The Counting Surface

The counting strip or "drag bed" must be cleared of vegetation and may be disked before the initial count (Daniel and Frels 1971). To obliterate old tracks, the surface is dragged the day before each count, preferably between 12 noon and 6 p.m. In Florida the frequent afternoon rains are usually sufficient to erase tracks, so that dragging is not always necessary. Rain cannot be relied upon for track obliteration in regions of low or inconsistent rainfall, but a moderate rain softens the surface for dragging the day afterward.

## Equipment

Basic equipment consists of a vehicle and drag assembly. A jeep or heavy-duty pickup truck is most commonly used to run the counts and pull the drag. A step with a vertical support or a boat chair (with seat belt) can be welded onto the front bumper to provide better visibility for the person counting tracks. A tractor or jeep with hydraulic blades can be used to clear the transect lines of vegetation if necessary; a tractor and disk plow will be needed if the lines are to be disked before the initial counts.

The drag mechanism is used for erasing tracks, marking transect boundaries, and pulverizing and smoothing the surface soil to make a suitable medium for recording track imprints. A harrow or a specially constructed assembly may be used for the drag mechanism. The flexible tyne harrow, which can be purchased through farm equipment retailers, consists of a 6-ft-wide steel bar attached to steel chain links that flow with the ground contours. It can be used with the tynes projecting downward to penetrate soil which has become rutted or crusted or can be inverted to smooth the surface. Other advantages of this drag assembly are ease of transportation and ability of the driver to use relatively high speeds while preparing the drag bed. The assembly weighs approximately 150 lb, rolls up to a diameter of 18 in., and attaches easily to a trailer hitch. With the harrow attached, a 4-wheel-drive vehicle can be driven from 30 to 35 mph.

A 3-ft-wide drag assembly can be constructed similar to that designed by Daniel and Frels (1971). The drag consists of a 36- × 10-in. metal plate with bolts or metal pegs protruding through the bottom to pulverize the soil, and a heavy chain attached to the back to smooth the disturbed surface. The drag is fastened to a metal framework that is bolted to the bumper; pivot points on both structures allow the drag to be lifted for easy transportation. Detailed descriptions and illustrations of drag assemblies are provided in Chapter 8, Equipment.

Understanding the functions of the drag, the manager may be able to reduce purchase costs by designing a suitable apparatus from local supplies. For example, mechanisms used in Michigan included a set of long heavy tire chains attached to the vehicle bumper and a 2- × 4-ft board fastened to chain-link fencing. Until recently, the Florida Game and Fresh Water Fish Commission routinely used a device as simple and available as an oak tree top.

## THE COUNTING PROCEDURE

Tracks are counted on a transect the morning following surface preparation. Counts may begin any time between sunrise and 8 a.m. but should be completed by midday so that the counter can take advantage of shadows, which enhance track visibility. Counting is generally performed by a team of 2 people. One person drives a pickup truck or other suitable vehicle at 5 to 10 mph, while the other person is positioned on the front of the truck recording tracks. When multiple crossings are present, the counter must leave the vehicle to accurately assess the number of tracks.

Tracks are tallied by 1/2-mile segments. Each set of tracks that enters the counting surface is counted, regardless of the direction of approach. Tracks may exit from the opposite or same side of entry. Tracks are counted only one time if a deer has obviously entered the counting surface more than once. Adult and fawn tracks are recorded separately when distinguishable, but they are added together for the total count. If apparent, adults with fawns may be noted. The fawn data can provide information about annual reproductive trends, especially in the absence of harvest data. An example of recording track patterns is illustrated in Figure 1.

A recommended form for recording track count data (modified from forms used by the Texas Parks and Wildlife Department and Florida Game and Fresh Water Fish Commission) is provided as Figure 2. One sheet is used for each daily count in a given area. Location refers to the unit being sampled. The general vegetation type for the location is recorded, and variations such as openings, hammocks, or creek bottoms are noted for each interval and preferably for each group of tracks. Additional information may be recorded as appropriate.

## PERSONNEL AND COSTS

Major costs to a project will generally be those of manpower and vehicle operation. A team of 2 people requires from 1 to 1.5 man-days to drag and count 10 to 15 miles of transect lines. As geographic factors and soil conditions are similar wherever this technique is applied, differences in time required to conduct the census result primarily from variations in distances traveled to and from sampling areas and between census lines. Factors to be considered in assessing total cost are: (1) salaries and per diem, based on

Figure 1. Example of recording individual sets of deer
tracks along a transect line

man-days required to census, and distance of sampling areas from operational
headquarters; (2) vehicle operation and maintenance, based on mileage, cost of
fuel, and upkeep of vehicles; and (3) equipment expenditures, chiefly purchase
costs.

## DATA ANALYSIS AND INTERPRETATION

### Population Density

The data collected from each census are totaled and used to estimate the
population density of deer within a given area. The equation for calculating
populations from count data is

$$P = \frac{T + M}{R} \times \frac{A}{640} \tag{1}$$

where:

   P = total population of area censused
   (includes all replicates)

   T = total number of tracks counted

   M = total number of miles censused

Date_____      Location_____

Time: from_____to_____      Line no. or name_____

Observer_____      Line length_____

Total miles_____      Habitat_____

Total count_____      Road preparation_____

Average tracks per mile_____      Weather conditions_____

| Mile | Number of Tracks | | | Vegetation |
|------|-------|------|--------------------|------------|
|      | adult | fawn | adult with fawn(s)  |            |
| 0.5  |       |      |                    |            |
| 1.0  |       |      |                    |            |
| 1.5  |       |      |                    |            |
| 2.0  |       |      |                    |            |
| 2.5  |       |      |                    |            |
| 3.0  |       |      |                    |            |
| 3.5  |       |      |                    |            |
| 4.0  |       |      |                    |            |
| 4.5  |       |      |                    |            |
| 5.0  |       |      |                    |            |
| Total |      |      |                    |            |

Figure 2. Track count data form for white-tailed deer

$R$ = diameter of average daily home range in miles
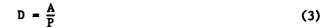
$A$ = total number of acres in area censused

640 = number of acres per square mile

The population per square mile is represented by $\frac{T + M}{R}$ . If $R$ is equal to 1 mile, the equation may be simplified to

$$P = \frac{T}{M} \times \frac{A}{640} \qquad (2)$$

or:

$$P = \frac{\text{total number tracks counted}}{\text{total number miles censused}} \times \frac{\text{acres in area censused}}{640}$$

The value obtained from this calculation represents the population, or number of deer in a given area. Population density can then be found by using the equation

$$D = \frac{A}{P} \qquad (3)$$

where:

$D$ = number of acres per deer

$A$ = total number of acres in area censused

$P$ = population of area, calculated from track count data

A hypothetical example of applying track count data to determine population density is shown in Example 1.

When dealing with large numbers of tracks, such as the season's total on a large area, the track count means can be substituted for $T$ and the number of miles of transect lines for $M$ . This procedure not only simplifies the computations but also allows for setting confidence limits on track count means. Confidence limits can be calculated for the total population, so that density estimates will be expressed within a range of values rather than as absolute values.

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Example 1

Calculation of Population Density from Track Count Data

Assume that 10 counts (replicates) were conducted on 6 miles of transect in an area of 12,000 acres; the total number of tracks counted was 1352. Substitute in Equation 2 to solve for deer population on the area:

$$P = \frac{T}{M} \times \frac{A}{640}$$

$$P = \frac{1352}{60} \times \frac{12,000}{640}$$

$$= 22.53 \times 18.75$$

$$= 422 \text{ deer (on 12,000 acres)}$$

The number of acres per deer is

$$D = \frac{12,000}{422}$$

$$= 28, \text{ expressed as 1 deer per 28 acres}$$

To express density in metric units, multiply the number of acres per deer D by 0.4047, the hectare equivalent of 1 acre. Therefore,

$$D = 28 \times 0.4047$$

$$= 11, \text{ expressed as 1 deer per 11 ha}$$

Note: If the average daily range of deer on this area had been 0.75 mile rather than 1 mile, adjustment would be made in the first term of the equation with the following results:

$$P = \frac{22.53}{0.75} \times 18.75$$

$$= 30.04 \times 18.75$$

$$= 563 \text{ deer}$$

Density would therefore be

$$D = \frac{12,000}{563}$$

$$= 21, \text{ expressed as 1 deer per 21 acres, or 1 deer per 8.5 ha}$$

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If the metric system is used for the census, kilometers and hectares will be substituted for miles and acres, respectively. The factor 1.609 (kilometers equivalent to 1 mile) should be included in the equation to preserve the proper ratio of tracks to density, and 100 (hectares/square kilometer) should be used instead of 640 (acres/square mile). The equation would become

$$P = \frac{T + K}{(R)\ (1.609)} \times \frac{A}{100} \tag{4}$$

where:

$P$ = total population of area censused

$T$ = total number of tracks counted

$K$ = total number of kilometers censused

$R$ = diameter of average daily home range in miles

1.609 = equivalence factor (1 track per mile = 1 track per 1.6 km)

$A$ = total number of hectares in area

100 = number of hectares per square kilometer

If home range $R$ is expressed in kilometers, the equivalence factor 1.609 should be omitted.

Calculation of Equation 4 gives the area population as number of deer per total number of hectares. To obtain population density $D$ as 1 deer per number of hectares, use Equation 3, $D = A/P$ , and substitute for $A$ the total number of hectares in the area.

Sample Size

The number of survey replications needed to adequately sample a given area can be determined by using the data obtained from the first complete census each year (Example 2). To find the sample size required to predict a specified percent change in track numbers within certain probability limits, use the following equation from Snedecor (1950, pages 456-458)

$$N = \frac{s^2 t^2}{d^2} \tag{5}$$

### Example 2

#### Determination of Adequate Sample Size

Assume that the first complete track count for a management area consisted of the following data collected from ten 2-mile transects:

| Transect Number | Tracks Counted (X) | $X^2$ |
|:---:|:---:|:---:|
| 1 | 126 | 15,876 |
| 2 | 122 | 14,884 |
| 3 | 172 | 29,584 |
| 4 | 96 | 9,216 |
| 5 | 146 | 21,316 |
| 6 | 122 | 14,884 |
| 7 | 59 | 3,481 |
| 8 | 148 | 21,904 |
| 9 | 138 | 19,044 |
| 10 | 182 | 33,124 |
| n = 10 | $\Sigma X$ = 1311 | $\Sigma X^2$ = 183,313 |
|  | x = 131 |  |
|  | $(\Sigma X)^2$ = 1,718,721 |  |

To solve for $s^2$ use the equation

$$s^2 = \frac{\Sigma X^2 - (\Sigma X)^2/n}{n - 1} \qquad (6)$$

where:

X = number of tracks counted on each transect
n = number of transects

$$s^2 = \frac{183,313 - 1,718,721/10}{9}$$

$$= \frac{183,313 - 171,872}{9}$$

$$= 1271$$

Using Equation 5, solve for the number of samples needed to predict a 20% change in track numbers 95% of the time.

$$N = \frac{s^2 t^2}{d^2}$$

$$= \frac{s^2 t^2}{[(x)\ (0.2)]^2}$$

$$= \frac{(1271)\ (2.26)^2}{[(131)\ (0.2)]^2}$$

$$= \frac{6491.8}{686.4}$$

$$= 10$$

This computation indicates that 10 counts of each transect would be required during the given year's sampling period to detect real population differences between years.

where:

        N = number of samples required

        s = standard deviation of the sample total

        t = normal deviate at a set confidence limit level and degrees of freedom (from statistical t table)

        d = margin of error (arithmetic mean, represented by x , of the sample total times the designated percent accuracy)

Example 2 illustrates the calculation of adequate sample size for a hypothetical track count census.

A greater number of surveys are required to detect small changes than to detect large changes in track numbers from year to year. The degree of accuracy is determined by the amount of percent change in track numbers that the manager wishes to detect and must therefore be established prior to the census. Harlow et al. (1973) recommended that enough counts be conducted in Florida to detect at least a 50% change in tracks 95% of the time. In Example 2, only two surveys would be sufficient to detect a 50% change, whereas 10 surveys are needed to detect a 20% change.

In Example 2 the number of tracks counted is high, an average of 66 per transect mile. If population density is lower, resulting in fewer tracks, more counts will be needed for adequate population estimates; that is, the needed sample size will increase to achieve the same degree of accuracy under the same probability limits. If only 460 tracks had been counted on the 20 miles of transect lines in Example 2, approximately 50 surveys per year would be necessary to detect a 20% change in tracks from the previous year. With these low counts, 50% accuracy could be used, and 8 surveys would constitute an adequate sample size.

## Annual Comparisons

The data for a given year should be subjected to analysis of variance to ascertain differences among the track count means of transect segments, transects, and areas within the total management unit. After 2 years of track counts, data can be analyzed for differences between years. If no unusual distributional changes occur within the herd, any significant population differences within areas or population changes between years can be found using Student's t test or the F test. Instructions for the computation of these

tests can be found in any standard statistical methods textbook, such as <u>Prin-</u>
<u>ciples and Procedures of Statistics</u> (Steel and Torrie 1960), <u>Biostatistical</u>
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